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TAXONOMIC REVISION OF THE GENUS *DIPLOSIPHON* EVDONIN, 1977 (PLATHELMINTHES, NEORHABDOCOELA, KALYPTORHYNCHIA), ENDEMIC TO LAKE BAIKAL, WITH THE DESCRIPTION OF TWO NEW SPECIES, A NEW DIAGNOSIS OF THE GENUS *DIPLOSIPHON* AND ESTABLISHMENT OF *D. BAIKALENSIS* NEOTYPE

by

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INTRODUCTION

The study of Turbellaria Kalyptorhynchia of Lake Baikal started after KOZHOV's discovery of a single specimen of a large, cherry-red colored kalyptorhynchian, which was collected near Bolshye Koty Bay (Southern Baikal) from 80 m depth.[1] The specimen was investigated by RUBTZOV (1929), who gave a very brief description and scheme of the general structure of the kalyptorhynchian, which was referred to the family Polycystididae VON GRAFF, 1905, as a new species of the genus *Acrorhynchus* VON GRAFF, 1882 : *A. baikalensis* RUBTZOV, 1929. NASSONOV (1930) believed that the species had been erroneously inserted in the genus *Acrorhynchus* and that it is much more closely related to the genus *Koinocystis* MEIXNER, 1924, but sufficiently different to warrant a new genus, "although at present we hould abstain from this separation, because the species is too poorly studied." Despite this opinion, EVDONIN (1977) erected the new genus *Diplosiphon* EVDONIN, 1977, within the family Koinocystididae MEIXNER, 1924, for *A. baikalensis* on the basis of RUBTZOV's original single specimen description.[2] KARLING (1980) in his "Revision of Koinocystididae" following NASSONOV (1930), mentions the species as insufficiently known with apparently doubtfully (even — erroneously) described female gonoducts and male copulatory apparatus. Therefore, *Diplosiphon baikalensis* was not included in KARLING's (1980) scheme of the phylogenetic relations of Koinocystididae. A revision of Baikal kalyptorhynchians (TIMOSHKIN, 1986a, b), based on the morphological analysis of rich new material (including 7 specimens of *D. baikalensis*), corrected earlier descrip-

1) For the sake of truth it should be mentioned that a paper of SIBIRJAKOVA (1929), describing rhabdocoel (including kalyptorhynchian) turbellarians mainly of Angara River and Baikal, also appeared in 1929.

2) MEIXNER (1924, pp. 121-122) described a new subfamily Koinocystidini. It was elevated to the rank of the family, *i.e.*, Koinocystididae by MEIXNER (1925, pp. 306-307). Thus, the name of the author and the date of the family establishment is Koinocystididae MEIXNER, 1924. Cf. ICZN (3rd ed., 1985, Art. 36).

Erroneous spellings of a Linnean name, "*Diplosyphon baicalensis*", are found in several parts of a previous paper by TIMOSHKIN (1986a).

tions of the taxon, included 6 more new species in *Diplosiphon*, and supported the ideas of NASSONOV (1930) and KARLING (1980). When Dr. Tor G. KARLING read these papers (TIMOSHKIN, 1986a, b), his conclusion was : "The genus *Diplosiphon*, in your interpretation, seems to be a non-monophyletic group" (KARLING, pers. comm.).

During the last 10 years, TIMOSHKIN has found in the lake about 40 new kalyptorhynchian species, and this has drastically changed his previous impression of the abundance and taxonomy of endemic Turbellaria Kalyptorhynchia of Lake Baikal in general, and about the systematic content of the genus *Diplosiphon* in particular. Now it is evident that Dr. KARLING was right and that the genus *Diplosiphon* (sensu TIMOSHKIN, 1986a) is a polyphyletic taxon.

The aim of this paper is to present the first results of the reconsideration of Baikal kalyptorhynchian systematics – a taxonomical revision of the "oldest" endemic genus of Baikal kalyptorhynchian turbellarians *Diplosiphon*, together with the description of 2 new species and 2 new subspecies and an emendation of the generic diagnosis. A key to the species and subspecies is presented, as well as a preliminary discussion on the phylogenetic relationships of the genus. Characteristics of the Baikal kalyptorhynchian fauna as a whole, in comparison with biota of other freshwater bodies (ancient lakes included), are briefly considered.

TIMOSHKIN is responsible for all of the taxonomic conclusions, presented in this paper.

Abbreviations in the text and figures are :

BS – bursa ; BP – bulbus of penis ; CO – cocoon ; CH – cuticular hooks ; DEJ – ductus ejaculatorius ; F – hook funnel ; FD – funnel diameter ; FMB – fragment of the bulbus muscle wall ; GO – genital opening ; GL – glands ; HL – hook length ; HM – hook muscles ; ID – isthmus diameter ; IN – intestine ; IS – isthmus ; K – knobs ; KD – knob diameter ; MB – Middle Baikal ; MO – mouth opening ; NB – Northern Baikal ; OC – eyes ; OV – ovaria ; OVD – oviduct ; P – penis ; PH – pharynx ; PI – hook pipe ; PP – penis papilla ; R – rhynchus (proboscis) ; SB – Southern Baikal ; T – testes ; UT – uterus ; VG – vesicula granulorum ; VID – vitelloduct ; VIT – vitellaria ; VS – vesiculae seminalis.

MATERIALS AND METHODS

The worms were collected from 1981 to 1995 during 5 expeditions around the lake and about 10 more local expeditions (aimed at investigating benthic invertebrates of the regions, well known for the richness and diversity of their benthic invertebrate fauna and even for so-called "supraendemism" [3] : largest bays of Baikal – Barguzin (MB), Chyvyrkui (NB), Aia (MB), Aiaia (NB) ; as well as Maloe More Strait (MB), Selenga Avandelta (SB), etc. In addition, investigations on several field biological stations were organized : in the winter of 1981–1982, turbellarians were collected monthly in the littoral of Listvyanichny Bay (SB) ; in the summer of 1982 – in the littoral of Ushkan'i Islands (between the Middle and Northern Baikal) ; in the summer of 1985 – in the littoral of Bolshye Koty Bay (SB). Expeditions in the summer or autumn seasons were usually organized on the ships of the Limnological Institute – "Titov", "Vereschagin" and "Obruchev", for an average of 3–4

3) One of the unique features of Lake Baikal fauna, which is about 60% endemic in general. Some bays and islands of the lake even have "their own" endemic species or subspecies. Ushkanyi Islands – one of the most famous examples : several subspecies and species of gammarids, ostracods, planarians, molluscs, etc., endemic to littoral zone of the islands, are known.

weeks. Bottom sediments were usually collected by middle drag (Prof. G. F. MAZEPOVA's model, LIN SD RAS) with the standard net of the stations, every station consisting of samples from depths of 5, 10, 25, 50, and 100 m. In the gulfs and bays, samplings from 120 and 200 m were usually included as well. For each expedition an average of 15–20 stations were included; stations were more or less equally distributed on the coastal perimeter of the region under study. Station expeditions were carried out on small boats in summer and through ice-holes in winter to investigate the turbellarian fauna mainly of rocky littoral. Divers and bottom samplers of different configuration were used in both cases. The sediments and stones with overgrowing algae, sponges, etc. were carefully washed in Baikal water and investigated under the dissecting microscope to pick out the turbellarians. The internal morphology of microturbellrians, especially those with cuticular structures in the copulatory apparatus, was studied in living, slightly squeezed animals. They were then usually embedded in Fore-Berlezet liquid, or in Canada balsam after classical carmine or hemalaun stainings (ROMEIS, 1954). Alternatively, worms were fixed in Bouin's fixative and routine histological techniques applied to investigate the internal organ structures.

Diplosiphon mamkaevi sp. n. is one of the most widely distributed species of Baikal kalyptorhynchian turbellarians and numerous specimens have been collected from many regions of the lake. Detailed information on the samplings of this species is therefore given separately in Table 1 and map of the sampling places (Fig. 17).

Measurements of *Diplosiphon* penial cuticular structures, used in the present paper, are shown in Fig. 8.

All material listed in the present paper, including the type series, is deposited in the Laboratory of Hydrobiology and Systematics of Freshwater Organisms, Limnological Institute SD RAS, Irkutsk, Russia.

TAXONOMIC DESCRIPTIONS

Phylum PLATHELMINTHES SCHNEIDER, 1873
Class TURBELLARIA EHRENBERG, 1831
Order NEORHABDOCOELA MEIXNER, 1938
Suborder KALYPTORHYNCHIA VON GRAFF, 1905
Family K o i n o c y s t i d i d a e MEIXNER, 1924
Genus *Diplosiphon* EVDONIN, 1977
(Figs. 1–16; Pls. I–II)

Synonymy:

Acrorhynchus: RUBTZOV, 1929 (pp. 132–138)
Koinocystis: NASSONOV, 1930 (pp. 586–588)
Diplosiphon: EVDONIN, 1977 (pp. 226–227)
Diplosiphon?: KARLING, 1980 (pp. 241–269)
Diplosyphon: TIMOSHKIN, 1986a (spelling error; generic diagnosis, based on correct redescription of the anatomy, p. 701)
Diplosyphon: TIMOSHKIN, 1994a (spelling error; pp. 45–50)
Diplosyphon: TIMOSHKIN, 1994b (spelling error; p. 192)

Type species : *Acrorhynchus baikalensis* RUBTZOV, 1929.

Diagnosis. Eukalyptorhynchian turbellarians with 2 eyes and cone-shaped proboscis ; pharynx, as a rule, in the anterior body third ; copulatory organ of conjuncta type, with clearly developed bulbus and papilla ; two tubular cuticular hooks[4] not related to release of sperm or any secretion, attached to lower proximal part of papilla by funnelform bases, usually smoothly curved with blind, roundish distal tips (Figs. 4, 6–8, 10, 11, 13–16 ; Pls. I–II) ; with at least 2 strong longitudinal muscles (hook promotors ?) inside of bulbus, attached at distal part of bulbus on one side and near the hook funnels at the other side ; basal hook funnels situated close to each other ; bulbus with homogeneously developed muscle wall (without thickenings) ; ductus ejaculatorius opens at the distal tip of papilla ; with bursa copulatrix and uterus ; bursa copulatrix channel with well-developed sphincter. Freshwater genus, endemic to Lake Baikal ; includes 3 known species ; one of which —*D. mamkaevi* sp. n.— consists of 2 subspecies.

Note : All 6 other species previously placed in this genus (TIMOSHKIN, 1986a) are transferred to other genera, descriptions of which will be published later.

Diplosiphon baikalensis (RUBTZOV, 1929)
(Figs. 1–4 ; Pl. I, Figs. A–C)

Synonymy : See Synonymy to the genus.

Description. Giant kalyptorhynchians from 7.5 to 8.4 mm long in motion, width from 2.0 to 2.5 mm (Figs. 1, 2) ; body color intense cherry-red with yellow patches in the proboscis, pharynx and copulatory apparatus regions ; proboscis pear-shaped, 2.0–2.5 mm long and 1.2–2.0 mm wide at the basis ; pharynx diameter nearly equal to the width of proboscis ; testes in the middle third part of body ; vesiculae seminalis of sexually matured worms kidney-shaped, very voluminous (Fig. 2) and about 1300 μm long ; diameter of the bulbus, when relaxed about 1000 μm ; muscle wall of the bulbus consisting of two layers : external layer of thin, circular muscles and internal layer of thick, longitudinal muscles (Fig. 3) ; two smoothly bent tubular cuticular hooks approximately 520 and 540 μm long (Figs. 3, 4 ; Pl. I, Figs. A–C) ; funnel diameter 170 to 237 μm ; distal tips of funnels without any extensions ; vitellaria strongly branched ; ovaria oval with length almost equal to the bulbus diameter.

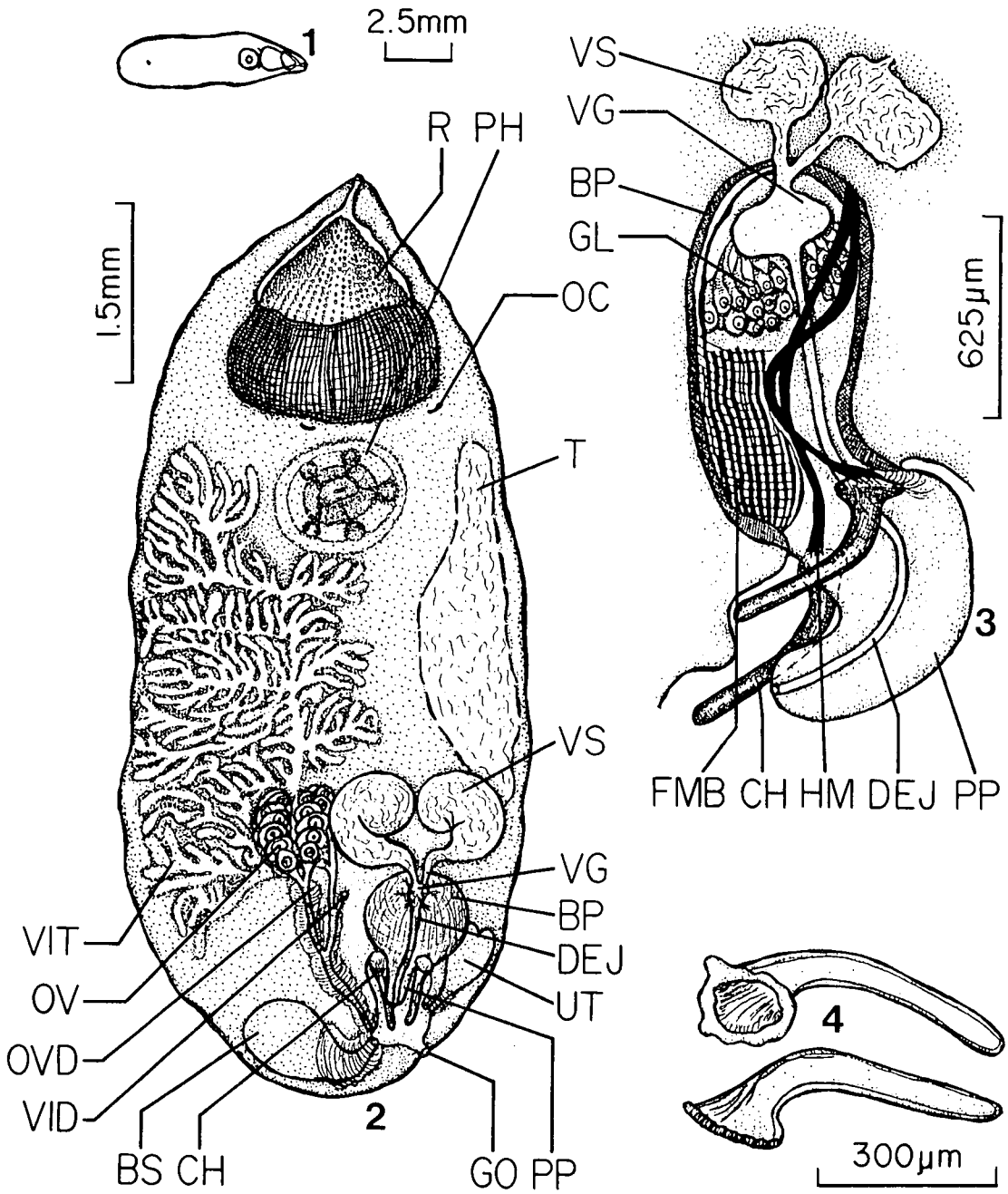
Comparison. Many unusual features, such as giant body size and different organs, color pattern, hooks structure, etc., readily distinguish *D. baikalensis* from other species of the genus. For other details, see *Comparisons* of *D. mamkaevi* and *D. wadai*.

Material. Six whole mounts, stained in carmine and embedded in Canada balsam : 19. 07. 1982, Aiaia Bay (NB), depth 25 m ; one whole mount, embedded in Fore-Berlezet liquid : 17. 09. 1984, Kocherikovskii Cape (MB), depth 12–14 m (neotype).

Additional note to the material. One set of histological sections of a single, badly preserved specimen formed the basis of both the original description of the species and the further erection of the genus. This resulted in the incorrect original description of the worm in general and its

4) In the previous paper (TIMOSHKIN, 1986a), the author used the term "stylets" instead of the term "hooks" introduced in kalyptorhynchian taxonomy by KARLING (1980). The latter term is more appropriate for *Diplosiphon* penial cuticular structures.

copulatory apparatus in particular. Therefore, this taxon was considered as species inquirenda. All preparations of RUBTZOV (type series) were lost. The above reasons justify the establishment of the neotype of *D. baikalensis*.



Figs. 1–4. *Diplosiphon baikalensis* (RUBTZOV, 1929) (after TIMOSHKIN, 1986a). 1, external view of an alive and moving worm ; 2, external view of the worm in squeezed condition : left testes and right vitellarium are not shown ; 3, copulatory organ of juvenile worm ; 4, hooks.

Type locality : Rocky littoral near Kocherikovsky Cape (MB), depth 12–14 m ; bottom : rocks with sand and overgrowing sponges.

Distribution. *D. baikalensis* is a rare, but widely distributed species, all over the littoral zone of Lake Baikal.

Diplosiphon mamkaevi TIMOSHKIN et KAWAKATSU, sp. n.
(Figs. 5–15, 17 ; Pls. I-II, Figs. D–H ; Table 1)

Description. Middle-sized worms (Fig. 5) : body length of sexually matured specimens in motion about 4 mm, width 0.5 mm ; when fixed either globe-shaped, with diameter about 1.5–2 mm, or oval, length 2.1–3 mm, width 0.8–2.1 mm ; body milk-white, tinged with brown, yellow or pink ; non-transparent (except for margins and anterior end near proboscis) ; length and width of the proboscis and diameter of the pharynx of moving worms approximately 620, 540 and 430 μm, respectively. In fixed specimens, these values vary from 280–600, 270–430, 330–520 μm, respective-

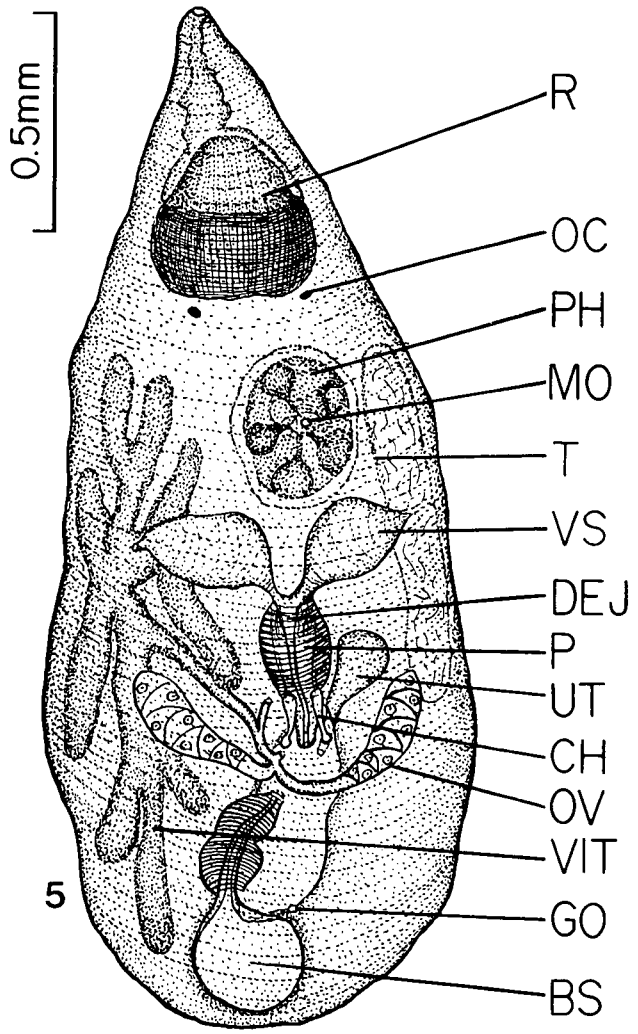


Fig. 5. *Diplosiphon mamkaevi* sp. n. External view : left testes and right vitellarium are not shown.

ly. Length of copulatory apparatus (without vesiculae seminalis) 400–520 μm ; width about 170 μm ; cuticular hooks (Figs. 6–8 ; 10–11 ; 13–15 ; Pls. I–II, Figs. D–H) smoothly curved in the middle part of the pipe, with more or less pronounced funnelform basis ; extensions at the distal tips of the hooks spherical (the most usual form, Figs. 6–8 ; Pl. I, Figs. D–F), lobe-like, irregular and flattened (quite common form, Figs. 10, 11), or egg-like (very rare form, Fig. 13 ; Pl. II, Figs. G–H). Detailed measurements of the hooks are given in the description of the nominotypical subspecies (see below). Vitellaria consisting of several lobes, ovaria small and elongated.

Cocoons. Yellowish-brown, usual rounded-oval (Fig. 9), rarely elongated-oval (Fig. 12), with smooth external surface. Specimens with cocoons have been found in autumn (during September–October).

Feeding pattern. Annelid (Oligochaeta) setae and diatom shells are the most usual and abundant recognizable gut contents.

Comparison. D. mamkaevi is readily distinguished from all other species of Baikal kalyptorhynchian turbellarians as well as from 2 other species of the genus. *D. mamkaevi* is clearly distinguished from *D. baikalensis* and from *D. wadai* by its very characteristic structure of the hooks as well as by its body size and coloration. It is the only *Diplosiphon* species, which as a rule has different forms of extensions on the distal tips of cuticular hooks. Moreover, the hooks of *D. mamkaevi* are much smaller than those of *D. baikalensis* – about one-third as long and half to one-third as wide at the funnel. For other details, see Comparisons of *D. m. mamkaevi* and *D. wadai.*

Material. More than 60 whole-mount specimens including 21 specimens (on 11 slides) in the type series (see Table 1).

Holotype. Whole-mount specimen, collected on 24. 10. 1992 in Nuga Bay, depth : 16–32 m ; bottom : silt with sand and detritus ; Slide No. 1 (24. 10. 1992.)

Paratypes. Whole-mount specimens from the Sample Nos. 16 and 21 (see Table 1) ; Slides No. 10 (28. 10. 1992) ; Nos. 1, 3 and 4 (12. 06. 1994).

Type locality : Littoral zone of Nuga Bay in Maloye More Strait, Middle Baikal (see Sample No. 15 in Table 1).

Distribution. The worms are widely distributed in Baikal, at depths of 1.5–100 m ; on sandy, silt and rocky bottoms (see Table 1 and map of the sampling places, Fig. 17, solid circles).

Etymology. The species is named in honor of the famous Russian taxonomist, Professor Dr. Yury V. MAMKAEV.

Additional comments. Based on small but consistent differences in the hook structure of worms inhabiting quite different regions of the lake, 2 common subspecies of *D. mamkaevi* are distinguished. In addition, 2 other forms, without doubt belonging to *D. mamkaevi*, but deviating from both subspecies of *D. mamkaevi* by some differences (mainly in hook structure), are also described below.

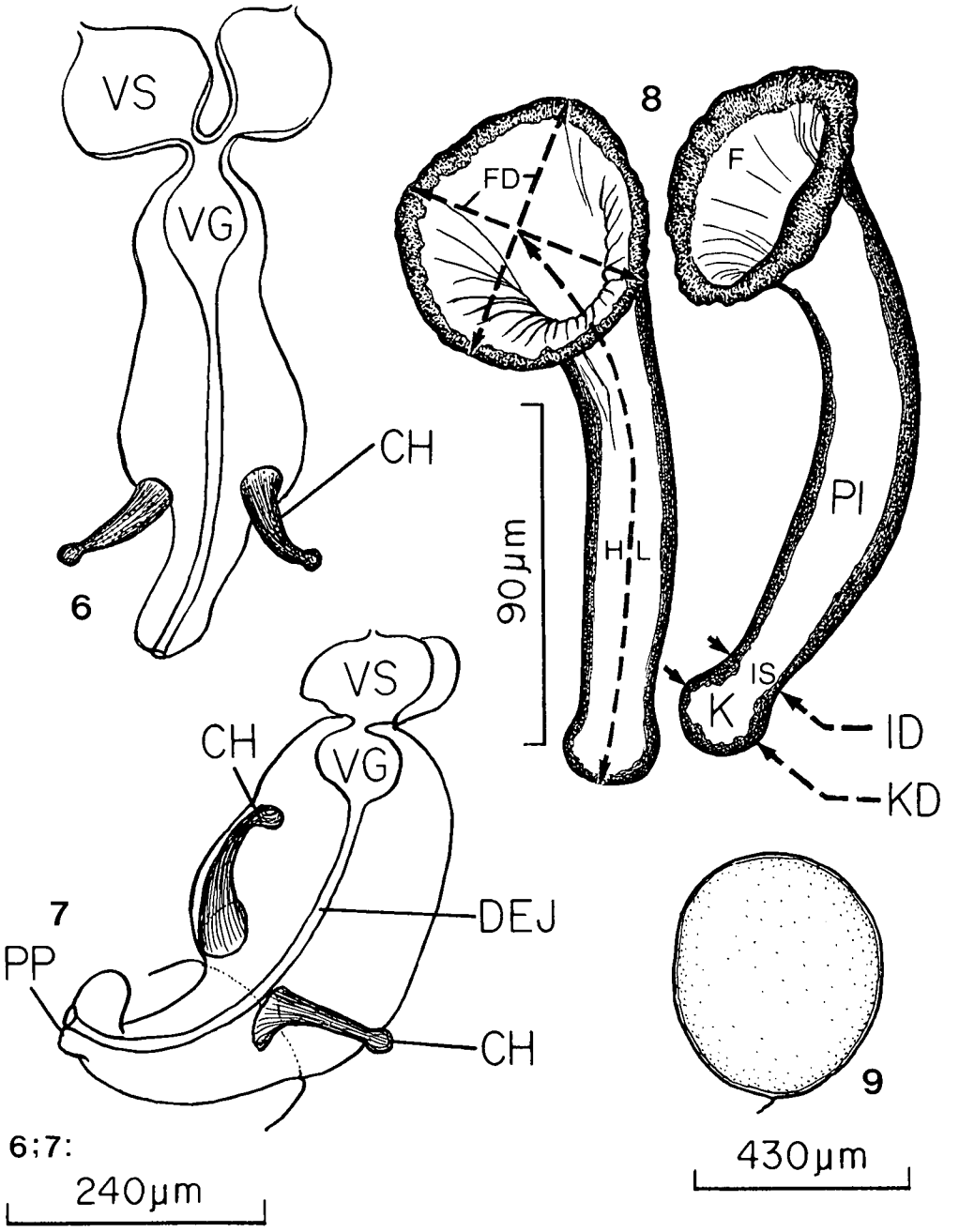
Diplosiphon mamkaevi mamkaevi TIMOSHKIN et KAWAKATSU, subsp. n.

(Figs. 5–9, 17 ; Pl. I, Figs. D–F ; Table 1)

Description. For size of the body, proboscis and pharynx, see *Description* of the species. In *D. m. mamkaevi,* the cuticular hooks have a well-developed broad and short funnel at the base and a well-pronounced isthmus and spherical protuberances at the distal tips (Figs. 6–8 ; Pl. I, Figs. D–F). Maximum diameter of the hook bases is, as a rule, almost 3 times more than the maximum diameter of their pipes ; transition of a funnel into a pipe is abrupt and distinct. On average, the diameter of

the isthmus is 1.38 (1.25–1.7) times less than the knob diameter. Maximum diameter of the hook bases varies from 55 to 77 μm ; distal knob diameter ranges from 19.6 to 25.5 μm ; length of the hooks proper from 145 to 169 μm.

Cocoon. Rounded ; maximum diameter 380–420 μm, wall thickness 3.9–8.8 μm.



Figs. 6–9. *Diplosiphon mamkaevi mamkaevi* subsp. n. 6 and 7, copulatory organs of 2 different worms ; 8, hooks ; 9, cocoon.

Comparison. The majority of the specimens examined (more than 50) have a well-developed broad funnel and very distinct protuberances at the distal tips of the cuticular hooks. In most cases both knobs are more or less spherical and clearly separated from the hook tube by an isthmus (Fig. 8 ; Pl. I, Figs. D–F). Hooks of the nominotypical subspecies are, on average, 2.6 times longer than those of *D. wadai*, and never have distal knobs which are flattened and shovel-shaped (as in *D. m. linius*, Figs. 10–11), or elongated, egg-shaped (as shown in Fig. 13).

Material. More than 50 whole-mount specimens, Sample Nos. 4–9 ; 11–13 ; 15–21 (see Table 1).

The holotype and paratypes of nominotypical subspecies, as well as the type locality and distribution were characterised above.

Diplosiphon mamkaevi linius TIMOSHKIN et KAWAKATSU, subsp. n.

(Figs. 10–11 ; Table 1)

Description. Length of fixed worms 900 to 1600 μm ; width 400 to 900 μm, correspondingly ; hook bases without a well defined funnel ; maximum diameter of the bases nearly equal to the maximum diameter of the pipes (Figs. 10–11) ; distal knobs usually well developed, flattened and shovel-shaped ; diameters of bases and knobs vary from 30 to 42 and from 12 to 24 μm, respectively ; hook length 92 to 113 μm.

Cocoons. Not known.

Comparison. Size of hooks in *D. m. linius* is intermediate between *D. m. mamkaevi* and *D. wadai*. None of the *D. m. linius* specimens examined had regular spherical knobs and developed basal funnel (especially not on both of the hooks) as in the nominotypical subspecies. The knobs of *D. m. linius* are as a rule flattened (one more characteristic feature) and have a quite different, often shovel-like shape (Figs. 10–11).

Material. Seven whole-mount specimens, including 4 of them in the type series (see Table 1, Sample Nos. 1–3).

Holotype. Whole-mount specimen, Slide No. 1, collected on 16. 04. 1982 ; littoral zone opposite LIN (common abbreviation of Limnological Institute SD RAS), rocks.

Paratypes. Slide No. 3 (5. 04. 1982) ; littoral zone opposite LIN, 2 whole-mount specimens ; Slide No. 1 (6. 04. 1982) ; littoral zone opposite LIN, whole-mount specimen.

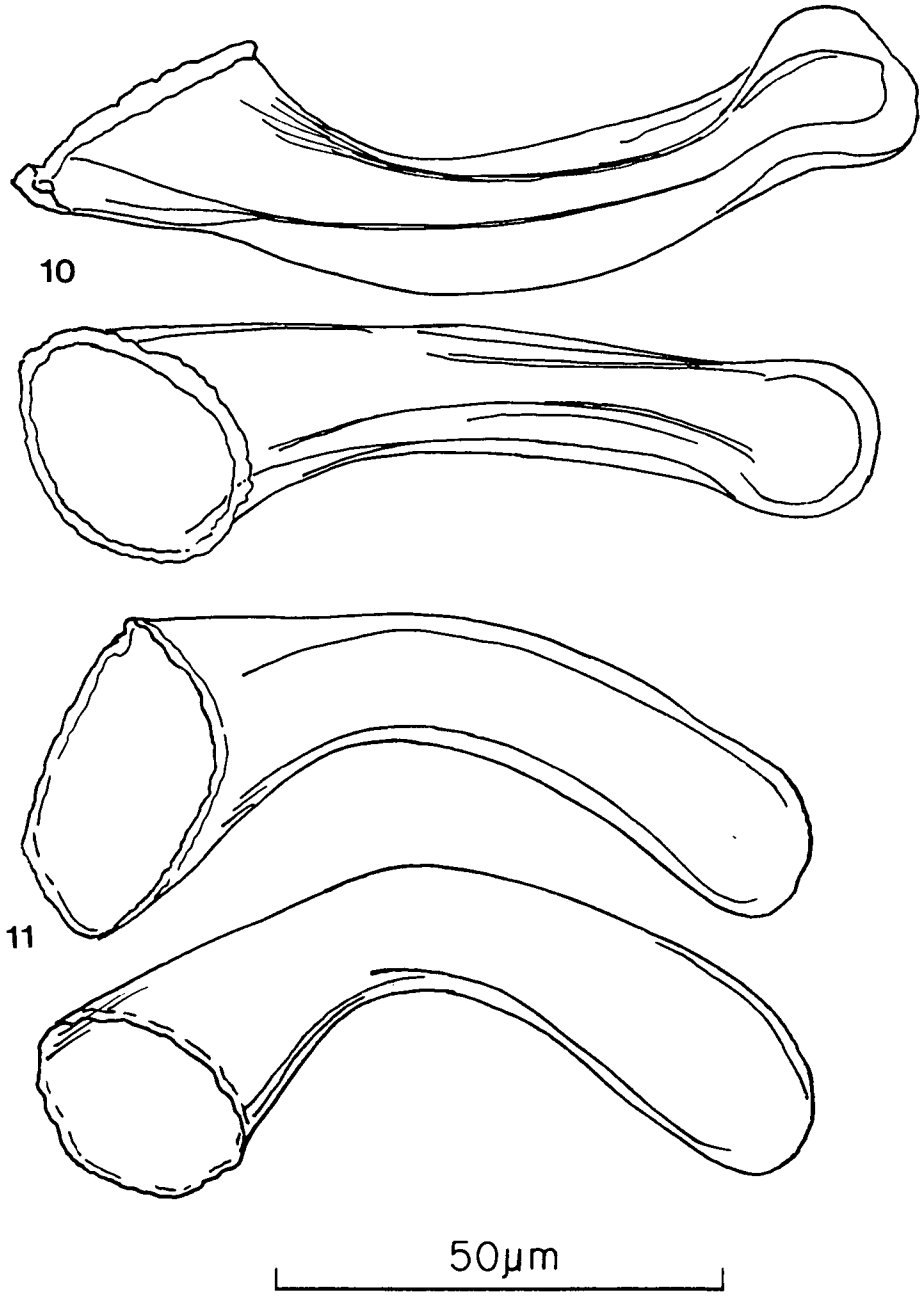
Type locality. Rocky littoral zone opposite LIN at Lisvianichnoe-na-Baikale (SB) ; depth 1–2 m.

Distribution. Rocky littoral zone of the west coast of SB, depth 1–2.5 m.

Etymology. The new subspecies is named in honor of the Limnological Institute (LIN) SD RAS on Baikal. (LIN+ ius = "be related to the LIN.")

Specimens provisionally included in *D. mamkaevi* sp. n.

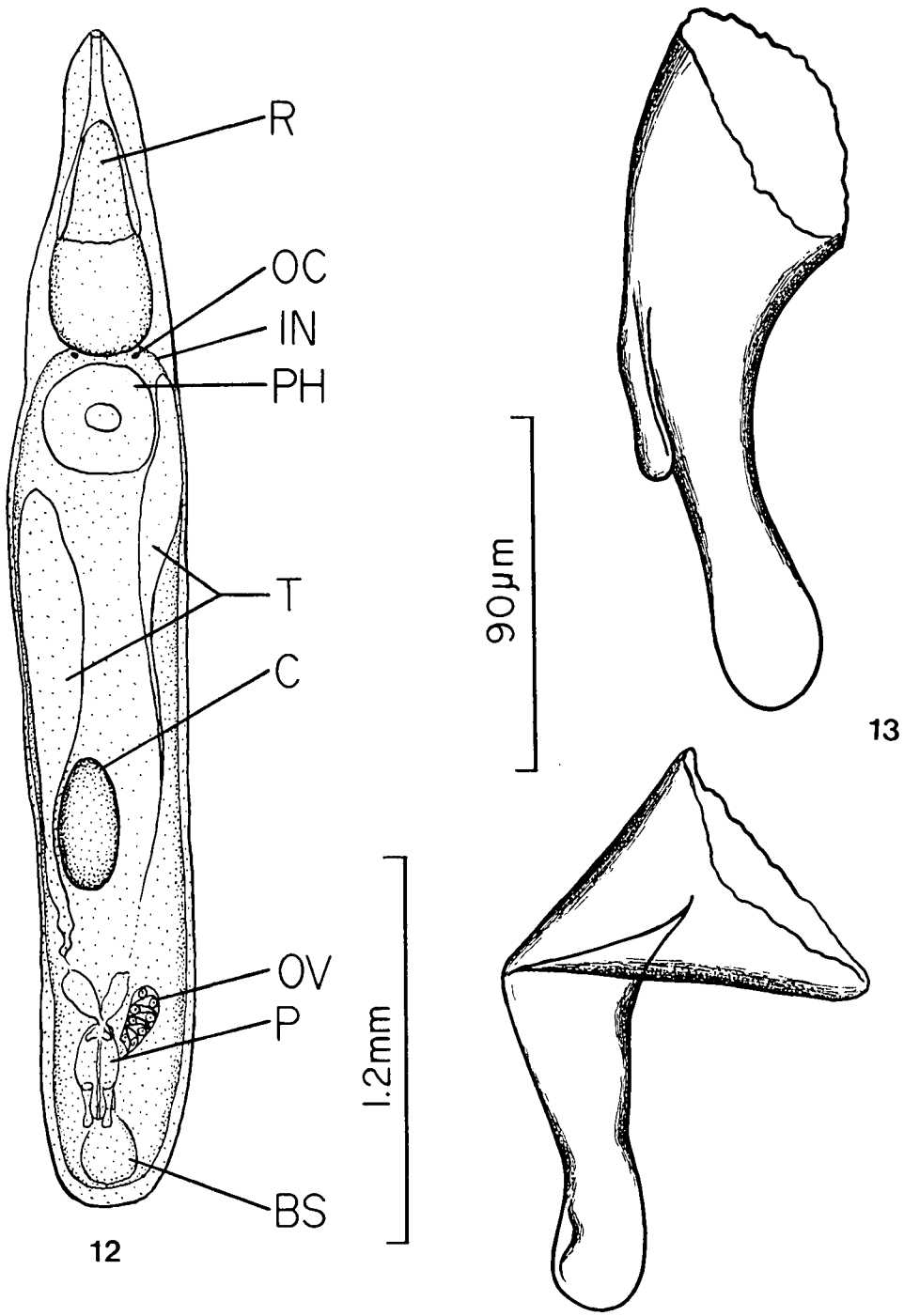
(1) A single specimen of *Diplosiphon* (Figs. 12 and 13 ; Pl. II, Figs. G and H) was collected from fine-grained sand with silt and detritus in the Sample No. 10 (Table 1) on 17. 09. 1984, taken near Sagan-Morian Cape (western coast of MB), at 100 m depth. Its most important features were similar to *D. m. mamkaevi* but some differences in the sexual system structure clearly distinguish this specimen from both subspecies of *D. mamkaevi* described above. The specimen was embedded in Fore-Berlezet liquid (whole-mount on Slide No. 2 (17. 09. 1984)). Body length of living



Figs. 10 and 11. *Diplosiphon mamkaevi linius* subsp. n. Hooks.

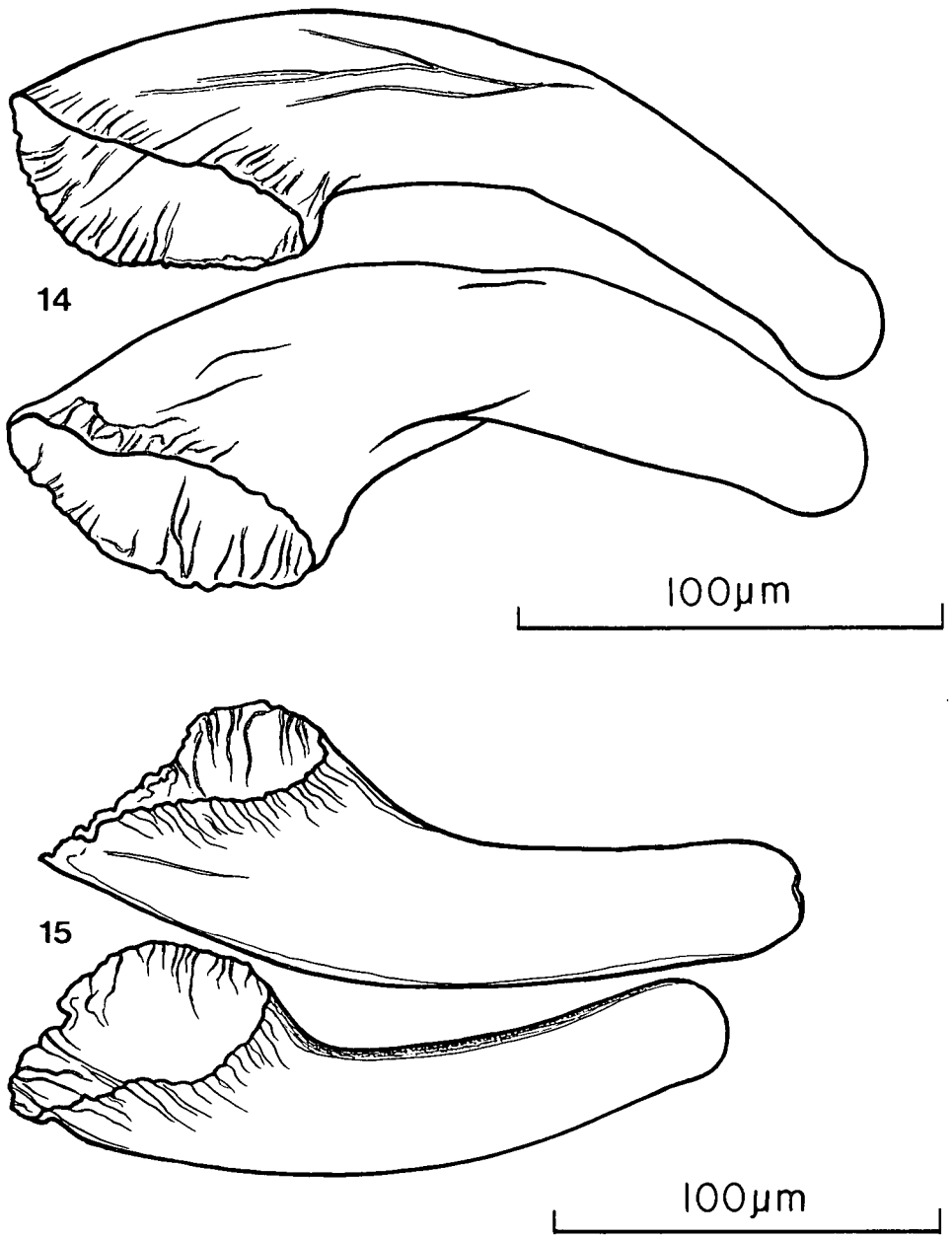
and moving specimen 3.6 mm, width 0.35 mm ; length and width of proboscis 370 and 450 µm, respectively ; pharynx diameter 300 µm ; cuticular hooks without a well-developed funnel at the basis, but with a well-pronounced isthmus and egg-shaped distal knobs (Fig. 13) ; maximum diameter of the hook bases 74 and 79 µm ; nearly equal to the maximum diameter of the pipes which narrow smoothly towards the isthmus ; diameters of egg-shaped knobs 27–28 µm (minimum) and 35–39 µm (maximum) ;

hook lengths 146 and 156 μm ; one of the hooks with an appendage of length 56.8 μm, width 7.8 μm ; with an oval cocoon about 400 ×270 μm.



Figs. 12 and 13. Specimen (1) provisionally included in *Diplosiphon mamkaevi* sp. n. 12, external view of alive and moving worm ; 13, hooks.

Remarks. In *D. m. mamkaevi*, cuticular hooks have their minimum diameter (isthmus) in the posterior 1/8–1/9 of the hook length, while the isthmus of this *Diplosiphon* specimen is situated in the posterior 1/3–1/4. Moreover, hooks of this specimen do not have a distinct basal funnel. Neither the terminal egg-shaped knobs of the specimen nor the elongated-oval form of the cocoon have been registered in any of the specimens of *D. mamkaevi* studied, except this one. The lateral branch of the hook tube (Fig. 13, upper hook) looks like a small copy of the hook itself; it also has a distal egg-shaped knob.



Figs. 14 and 15. Specimens (2) provisionally included in *Diplosiphon mamkaevi* sp. n. Hooks.

(2) Two specimens of *Diplosiphon* with penial hooks slightly different from *D. m. mamkaevi* and *D. m. linius* were found in the Sample No. 14 (Table 1) collected on 23. 09. 1990, near Maksimikha Village, Barguzin Bay (easten coast of the MB), from coarse-grained sand at 20 m depth. Both worms were embedded in Fore-Berlezet liquid (whole-mount specimens on the Slide No. 2 (23. 09. 1990)). Body length of fixed specimens 2.0–2.8 mm ; width 0.7–1.0 mm ; diameter of proboscis 530–570 μm ; diameter of pharynx approximately 340 μm ; basal funnel, distal isthmus and spherical knobs of the hooks little or not developed (Figs. 14–15) ; maximum diameter of hooks base (funnel) 75 to 84 μm, almost equal to maximum diameter of pipes ; diameter of distal knobs 26 to 32 μm ; hook length from 180 to 202 μm.

Remarks. The worms collected in Barguzin Bay have maximum hook length within the range for *Diplosiphon* species, except *D. baikalensis* (the hooks of which are at least 3 times longer and never form any distal knobs). Hook basal funnel is also not developed. Distal isthmus and knobs are indistinct in comparison to *D. m. mamkaevi*, and in contrast to the nominotypical subspecies, the maximum diameter of the isthmus is only 1.15 times less than knob diameter (Figs. 14–15) ; knobs, if present, are spherical.

Diplosiphon wadai TIMOSHKIN et KAWAKATSU, sp. n.
(Fig. 16 ; Pl. II, Figs. I and J)

Description. Small-sized worm ; body length in fixed condition 610 μm ; width 320 μm ; cuticular hooks small, with well-developed base funnels and distal spherical knobs (Fig. 16) ; isthmus not developed ; maximum base (funnel) diameter 33.3 μm, nearly double the maximum diameter of the pipes ; diameter of knobs 5.9 μm ; length of each hook approximately 43 μm.

Cocoons. Not known.

Comparison. Despite the description being based on a single specimen, characteristic features of body size and organ size and structure in *D. wadai* warrant the recognition of this new species distinct from both diplosiphons described above. *D. wadai* has the smallest body size between the species of the genus known so far ; length of the hooks is approximately one-quarter of that in *D. mamkaevi* and one-twelfth of that in *D. baikalensis*. Distinct spherical knobs are well developed, but only one-third to one-quarter the size of those in *D. mamkaevi*. Moreover, there is no isthmus between knobs and tube of the hooks.

Material. A single specimen collected on September 11, 1986 (Sample No. 6) : off Sukhoy Ruchey (depth, 10 m) ; black sands with detritus and mica particles.

Holotype. Whole-mount specimen No. 1 on the Slide, dated by September 11, 1986, with the sampling place indication.

Type locality. Littoral zone off Sukhoy Ruchey, Southern Baikal (see Fig. 17, an open arrow and a symbol with encircled solid square).

Fig. 16. *Diplosiphon wadai* sp. n. Hooks.

Etymology. The new species is named in honor of Professor Dr. Eitaro Wada, Director of the Center for Ecological Research of Kyoto University, Japan.

Key to Species and Subspecies of the Genus *Diplosiphon*

1 (2) Cuticular hooks without any distal knobs; hook length 520–540 μm; funnel diameter 170–237 μm; body cherry-red, not transparent; adult worms about 7.5–8.4 mm in length ..... *D. baikalensis* (RUBTZOV, 1929)

2 (1) Cuticular hooks with more or less developed knobs on the distal tips; hook length between 43 and 169 μm; funnel diameter 33–85 μm; adult worms 0.6–4 mm in length.

3 (4) Distal knobs spherical (20–25 μm in diameter), with distinct isthmus, clearly separating them from the tube of the hooks; hook length 145–169 μm; funnel diameter 55–77 μm; body milk-white, non-transparent, 2–4 mm in length ..... *D. mamkaevi mamkaevi* subsp. n.

4 (5) Distal knobs flattened and mostly shovel-shaped (12 to 24 μm width), without distinct isthmus; length of hooks 90 to 115 μm; funnel diameter 30–42 μm, body non-transparent, 0.9 to 2 mm in length. ..... *D. mamkaevi linius* subsp. n.

5 (3) Distal knobs spherical (6 μm in diameter), without distinct isthmus, but clearly separated from the hook; hook length 43 μm; funnel diameter 33.3 μm; body colorless, transparent, about 0.6 mm in length ..... *D. wadai* sp. n.

CONCLUSION

Evidently, it would be premature to establish the exact phylogenetic relationships of the genus *Diplosiphon* within the family Koinocystididae without consideration of the abundant diversity of endemic koinocystidid of Lake Baikal in general (see below). That is beyond the scope of the present contribution and will be published later. Nevertheless, a preliminary phylogenetic discussion is possible and appropriate. Several assumptions concerning phylogenetic reationships of *D. baikalensis* have already been proposed. According to EVDONIN's (1977) phylogenetic tree of Koinocystididae, *Diplosiphon* is related to *Koinocystis*. In KARLING's (1980) view, the atrial organs, strong proboscis sphincter and many other features indicate a close affinity of *D. baikalensis* to species of the genus *Itaipusa* MARCUS, 1949. As suggested by TIMOSHKIN (1986a), within Koinocystididae only species of the genus *Paratenerrhynchus* BRUNET, 1972 (namely, *P. triplex* BRUNET, 1972) show close similarity to *Diplosiphon* in the structure of the male sexual system. Representatives of both genera are characterized by separation of the penis into a well-developed bulbus and a papilla[5]) and the presence of a) paired vesiculae seminalis; b) vesicula granulorum, situated in the bulbus basis; c) two hooks

which are not involved in release of any secretion and are situated at the basis of the penis papilla. In contrast to the *Diplosiphon* species, the bulbus muscle wall of *Paratenerrhynchus* has paired thickenings in the bases of the hooks ; there are no longitudinal muscles (hook promotors) inside of the bulbus and the hooks are not tubular nor curved and have another form.

Analysis of the structure of the male copulatory organ of *Diplosiphon* does not support the coclusions of EVDONIN (1977) and KARLING (1980). The penial cuticular structure of *Koinocystis* species is a true stylet (not a hook), shaped like an unpaired tube ; the penis does not have a structure resembling the vesicula granulorum and papilla of diplosiphons. In *Diplosiphon* there is no separation of the ejaculatory duct from the prostatic ducts, although KARLING (1980, p. 266) proposed this apomorphy (separation of the ducts) for the first phylogenetic branch (to which *Itaipusa* belongs) within Koinocystididae. Moreover, the prostatic glands of *Diplosiphon* species mostly open into a specialized, separate, very well-developed enlargement of the proximal part of the ductus ejaculatorius in the basal part of the bulbus (Figs. 3, 6, 7). This enlargement was identified as vesicula granulorum, in analogy to that organ in other turbellarians (TIMOSHKIN, 1986a), without consideration of any phylogenetic significance. According to the evolutionary stages and typology schemes of koinocystidid male copulatory organs, developed by KARLING (1980), such a structure of the male copulatory organs in *Diplosiphon* species would most likely be considered as plesiomorphic within the family.

Hopefully, future investigation will determine whether the close similarity of male copulatory systems in *Paratenerrhynchus* and *Diplosiphon* indicates a close relationship or is due to independent parallel evolution of similar morphological characteristics.

It is already universally accepted that the most abundant faunas of kalyptorhynchian worms in general and koinocystidid worms in particular are known from marine ecosystems (EVDONIN, 1977 ; KARLING, 1980 ; CANNON, 1986 ; etc.). For example, freshwaters of Eurasia (excluding Baikal) are inhabited by about 10 species of the worms (EVDONIN, 1977), mostly non-endemic and widely distributed throughout the continent. From 38 species listed in the most recent Koinocystididae review (KARLING, 1980), only 6 (including *D. baikalensis*) inhabit freshwater basins. Even if we consider the entire animal world of the ancient lakes of the Earth (*i. e.*, Ohrid, Khubsugul, Biwa, Tanganyika, Titicaca, Caspian Sea, etc.), well known for high degrees of endemism, uniqueness and abundance of their biotas (MAMKAEV, 1968 ; DYGANOVA, 1983 ; DYGANOVA & PORFIRJEVA, 1990 ; COULTER, 1991, 1994 ; DEJOUX & ILTIS, 1992 ; NAKAJIMA & NAKAI, 1994 ; STANKOVIĆ, 1960 ; TIMOSHKIN, 1986a ; 1996 ; KOSAREV & YABLONSKAYA, 1994 ; etc.), we will not find any analogous fauna, more or less comparable in abundant diversity and endemism to Baikal kalyptorhynchian taxa. Considering only TIMOSHKIN's published papers the lake is inhabited by 9 koinocystidid and 6 polycystidid species ; all of them are endemic, except *Gyratrix hermaphroditus* EHRENBERG, 1831 (TIMOSHKIN, 1986a, b ; 1994a,b ; 1996 ; TIMOSHKIN & KAWAKATSU in the present contribution). Results of TIMOSHKIN's recent investigations show that in fact Baikal kalyptorhynchian fauna consists of not less than 31 species of Koinocystididae (belonging to 5 genera, endemic to the lake ; 4 of them are new for science) and 16 species of Polycystididae, most of which are also endemic (TIMOSHKIN, 1996 ; unpublished data). Therefore, the Baikal fauna of kalyptorhynchian platyhelminths at the present state of our knowledges should be considered as unusual and an exceptional phenomenon for

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5) There are some inconsistencies in BRUNET's (1972) description. In the generic diagnosis of *Paratenerrhynchus (op. cit.*, p. 165), he wrote : "Pas de papille péniale" (*i. e.*, without penis papilla). However, in his figure of the copulatory apparatus of *P. triplex* (fig. 17 on p. 168), a well-developed structure of 'penis papilla (?)' can be seen (notice "canal éjaculateur").

a freshwater ecosystems. The origin and phylogenetic relationships of endemic Koinocystididae in general and *Diplosiphon* genus in particular remain uncertain and open for further investigations. It should be considered as one of the interesting zoogeographical enigmas (which Baikal has introduced in abundance to biologists) that much closer morphological relationships are evident between these endemic Koinocystididae species flocks inhabiting freshwater Lake Baikal and marine Kalypto-

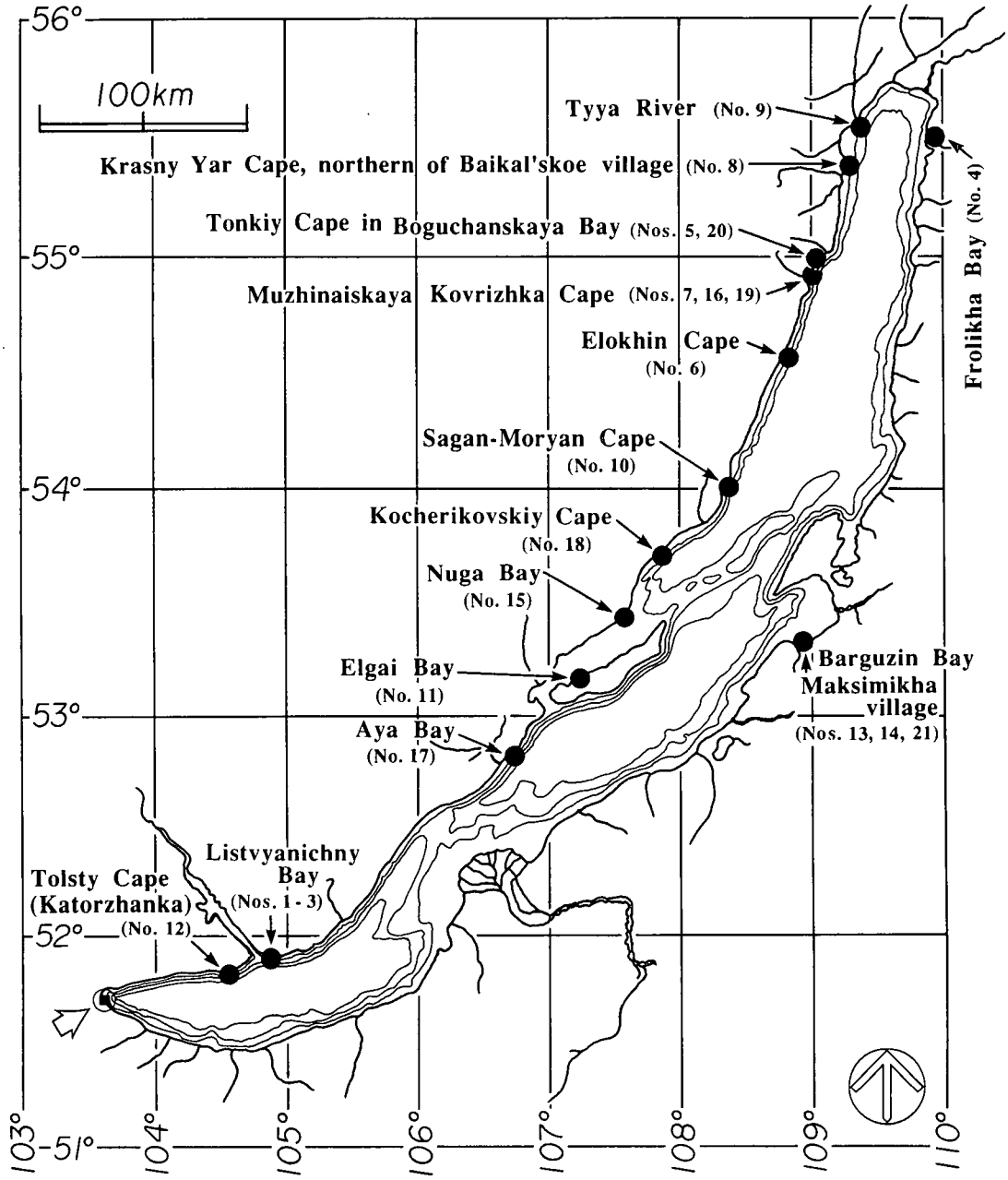

Fig. 17. Sketch-map of Lake Baikal showing sampling places of *Diplosiphon mamkaevi* sp. n. (solid circles). Numbers given in parentheses correspond to the Sample Numbers shown in Table 1. The type locality of *Diplosiphon wadai* sp. n is also shown (an open arrow and a symbol with encircled solid square in Southern Baikal).

Table 1. Characteristics of Lake Baikal sampling places of *Diplosiphon mamkaevi* sp. n.

Sample number	Date	Sampling place	Depth (m)	Type of bottom	Number of specimens examined	Remarks
1–3	April 1, 5, 6, 16, 1982	Listvyanichny Bay, opposite of Limnological Institute	1.5–2	Rocks with overgrowing algae, sponges	9	
4	19. 07. 1982	Frolikha Bay	25	Coarse-grained sand	1	
5	21. 07. 1982	Tonkiy Cape in Boguchanskaya Bay	10	Sand with algae, detritus	1	
6	10. 09. 1984	Elokhin Cape	14–35	Silty sand, rocks	1	
7	10. 09. 1984	Muzhinaiskaya Kowrizhka Cape	25	Silty sand, detritus	6	With cocoons
8	12. 09. 1984	Krasny Yar Cape, Northern of Baikal'skoe Village	38–40	Fine-grained silty sand, detritus	1	
9	12. 09. 1984	Opposite to Tyya River mouth	25–30	Coarse-grained silty sand, detritus	4	With cocoons
10	17. 09. 1984	Sagan-Moryan Cape	100	Fine-grained sand with silt, detritus	1	With cocoons
11	18. 09. 1984	Elgay Bay in Maloe More Strait	25	Fine-grained silty sand, detritus	3	
12	9. 06. 1986	Tolsty Cape (Katorzhanka)	5–10	Middle-grained sand, rocks with sponges	1	
13	23. 09. 1990	Barguzin Bay near Maksimikha Village	20	Coarse-grained sand with rare rocks	More than 10	With cocoons
14	23. 09. 1990	Barguzin Bay near Maksimikha Village	20–22	Coarse-grained sand with rare rocks	2	
15	24. 10. 1992	Nuga Bay in Maloe More Strait,TYPE LOCALITY	16–32	Silt with fine-grained sand	1 specimen, HOLOTYPE	With cocoons
16	28. 10. 1992	Muzhinaiskaya Kowrizhka Cape	5	Silty sand, detritus	1 specimen, PARATYPE	
17	8. 10. 1993	Aya Bay	5	Fine-grained sand, algae	1	With cocoons
18	11. 10. 1993	Kocherikovskiy Cape	11–30	Fine-grained silty sand	1	
19	13. 10. 1993	Northern of Muzhinaiskaya Kowrizhka Cape	5	Silty sand, detritus	3	With cocoons
20	14. 10. 1993	Boguchanskaya Bay	10–25	Middle-grained sand, detritus	2	
21	12. 06. 1994	Barguzin Bay near Maksimikha Village	20–22	Middle-grained sand, rare rocks with sponges	More than 15 specimens, including PARATYPES	

rhynchia, than between the former and any of the other freshwater kalyptorhynchian genera. This enigma is more remarkable considering that Baikal has never been in direct connections to any seas or ocean (MATZ, 1993).

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SUMMARY

The first results of a taxonomic revision of the Baikal kalyptorhynchian turbellarian fauna are presented. A new diagnosis is given of the endemic genus *Diplosiphon* EVDONIN, 1977, which at present includes only 3 species: *D. baikalensis* (RUBTZOV, 1929)(type species), *D. mamkaevi* sp. n. with two subspecies, and *D. wadai* sp. n. The neotype for *D. baikalensis* is established. Hypotheses of *Diplosiphon* relationships are briefly discussed. General characteristics of Baikal kalyptorhynchian fauna are given in comparison with analogous faunas of other freshwater basins (including ancient lakes).

REFERENCES

A standard style of romanization of Cyrillic alphabet is employed in this "References". Titles of foreign language printed in original Russian papers are shown in parentheses. For Russian papers which have none of titles of any foreign language, we have added the English titles in brackets.

BRUNET, M., 1972. Koinocystididae de la région de Marseille (Turbellaria, Kalyptorhynchia). Zool. Scripta, 1 (3–4): 157–174.

CANNON, L. R. G., 1986. *Turbellaria of the World. A Guide to Families & Genera.* i–viii + 1–136 pp. Queensland Museum, South Brisbane.

COULTER, G. W. (ed.), 1991. *Lake Tanganyika and its Life.* i– viii + 1–354 pp. Oxford Univ. Press, London. 1994. Lake Tanganyika. Arch. Hydrobiol. Ergeb. Limnol. (Advanc. Limnol.), 44 (K. MARTENS, B. GODDEERIS & G. COULTER, eds., "Speciation in Ancient Lakes"): 13–18.

DEJOUX, C. & ILTIS, A. (eds.), 1992. *Lake Titicaca: A Synthesis of Limnological Knowledge.* Monographiae Biologicae, 68. i–xxiv+ 1–574 pp. Kluwer Acad. Publ., Dordrecht.

DYGANOVA, R. YA., 1983. *Resnichnye Chervi (Turbellaria, Tricladida) Kaspiĭskogo Morĭa.* [Ciliated worms (Turbellaria, Tricladida) of Caspian Sea.] 1–112 pp. Izdatel'stvo Kazanskogo Univ.,

Kazan. (In Russian.)

DYGANOVA, R. YA. & PORFIRJEVA, N. A., 1990. *Planarii Aziatskoĭ Chasti SSSR. Morfologiia͡, Sistematika, Rasprostranenie.* [Planarians of the Asian Part of the USSR - Morphology, Systematics and Distribution.] 1–151 pp. Izdatel'stvo Kazanskogo Univ., Kazan. (In Russian.)

EHRENBERG, C. G., 1831. *Animalia Evertebrata Insectis.* In : HEMPRICH, F. G. & C. G. EHRENBERG (eds.),"*Symbolae Physicae*". Vol. 4, Series prima cum tabularum decade prima. Berolini. Note : This publication has no pagenation. "GYRATRIX, Nov. Gen." and "*Gyratrix hermaphroditus*" are described under No. 24 (and footnote 1) in 'PHYTOZOA TURBELLARIA Africana et Asiatica in Phytozoorum Tabula IV et V. Delineata.'

EVDONIN, L. A., 1977. *Fauna SSSR. Turbelli͡arii. I (1). Khobotkovye Resnichnye Chervi Kalyptorhynchia Fauny SSSR i Sopredel'nykh Stran.* [Fauna of the Rostellar Ciliated Worms (Kalyptorhynchia) of USSR and Surrounding Regions. USSR Fauna. Turbellaria]. 1–399 pp. Izdatel'stvo Nauka, Leningrad. (In Russian.)

GRAFF, L. VON, 1882. *Monographie der Turbellarien. I. Rhabdocoelida.* 1–422 pp.+pls. I–XII. Akad. Wissenschaften zu Berlin, Leipzig. 1905. Marine Turbellarien Orotavas und der Küsten Europas. II. Rhabdocoela. Zeitschr. Wiss. Zool., 83 : 68–150+ pls. II–VI.

INTERNATIONAL TRUST FOR ZOOLOGICAL NOMENCLATURE IN ASSOCIATION WITH BRITISH MUSEUM (NATURAL HISTORY) LONDON, 1985. *International Code of Zoological Nomenclature, Third Edition Adopted by the XX General Assembly of the International Union of Biological Sciences* (a French title omitted). Pp. i-xx+1-338. Univ. California Press, Berkelet and Los Angeles (printed by H. Charlesworth & Co. Ltd., Huddersfield, England).

KARLING, T. G., 1980. Revision of Koinocystididae (Turbellaria). Zool. Scripta, 9 : 241–269.

KOSAREV, A. N. & YABLONSKAYA, E. A., 1994. *The Caspian Sea.* 1-259 pp. SPB Academic Publ., Den Haag.

MAMKAEV, YU. V., 1968. Tip Ploskikh Chervei Plathelminthes. [Phylum Plathelminthes.] In : Atlas Bespozvonochnykh Kaspiiskogo Moria, pp. 51–63. [Atlas of Invertebrates of Caspian Sea.] Izdatel'stvo Pischevaja Promyshlennost'. (In Russian.)

MARCUS, E., 1949. Turbellaria Brasileiros (7). Bol. Fac. Filos., Ciênc. Letr., Univ. São Paulo, Zoologia, (14) : 7–155 (+ pls. I–XXII).

MATZ, V. D., 1993. The structure and development of the Baikal rift depression. Earth Sci. Reviews (Elsevier Sci. Publ. B. V.), 34 : 81–118.

MEIXNER, J., 1924. Studien zu einer Monographie der Kalyptorhynchia und zum System der Turbellaria Rhabdocoela. Zool. Anz., 60 : 113–125. 1925. Beitrag zur Morphologie und zum system der Turbellaria–Rhabdocoela. I. Die Kalyptorhynchia. Zeitschr. Morph. Ökol. Tiere, 3 : 255–343+pls II–III. 1938. Turbellaria (Strudelwürmer). Tierwelt Nord- und Ostsee, IV b : f–146.

NAKAJIMA, T. & NAKAI, K., 1994. Lake Biwa. Arch. Hydrobiol. Ergeb. Limnol. (Advanc. Lilmol.), 44 (K. MARTENS, B. GODDEERIS & G. COULTER, eds., "Speciation in Ancient Lakes") : 43–54.

NASSONOV, N. V., 1930. Ob *Acrorhynchus baicalensis* RUBTZOV iz ozera Baĭkal. (Über *Acrorhynchus baicalensis* RUBTZOFF aus dem Baikalsee.) Dokl. Akad. Nauk SSSR, 10 (22) : 586–588. (In Russian, with German summary.) Note : This author used an erroneous spelling "*A. baicalensis*".

ROMEIS, B., 1954. *Mikroskopicheskaia Tekhnika.* 1–712 pp. (*The Microscopical Technique.*) Izdatel'stvo Inostrannaja Literatura, Moscow. (In Russian.)

RUBTZOV, I. A. (=RUBTZOFF, I. A.), 1929. *Acrorhynchus baikalensis* sp. n. (*Acrorhynchus baikalensis* sp. n.). Russk. Gidrobiol. Zhur., Saratov, 8 : 132–138. (In Russian, with English summary.)

SCHNEIDER, A., 1873. Untersuchungen über Plathelminthen. Vierz. Bericht. Oberhess.

Ges. Natur- und Heilkunde, Giessen, 14 : 69–140+pls. III–VII.

SIBIRJAKOVA, O. A., 1929. K faune turbelliarii Rhabdocoela reki Angary. (La faune des Turbellaria Rhabdocoelida du fleuve Angara.) Russk. Gidrobiol. Zhur., 8 : 236–250. (In Russian, with French title.)

STANKOVIĆ, S., 1960. *The Balkan Lake Ohrid and Its Living World.* Monographie Biologicae, 9. 1–357 pp. Dr. W. Junk Publ., Den Haag.

TIMOSHKIN, O. A., 1986a. Khobotkovye resnichnye chervi (Turbellaria, Kalyptorhynchia) iz Ozera Baikal. 1. Novye vidy roda *Diplosyphon* i ego sistematicheskoe polozhenie. (Rostellar ciliated worms (Turbellaria, Kalyptorhynchia) from the Lake Baikal. 1. New species of the genus *Diplosyphon* and their taxonomic position.) Zool. Zhur., 65 (5) : 700–712. (In Russian, with English summary.) 1986b. *Do.* 2. Predstaviteli rodov *Opisthocystis* i *Gyratrix. (Do.* 2. Members of the genera *Opisthocystis* and *Gyratrix.*) Zool. Zhur., 65 (7) : 973–980. (In Russian, with English summary.) 1994a. Proiskhozhdenie i evoliuziia fauny svobodnozhivushchikh resnichnykh chervei (Turbellaria) ozera Baĭkal. (Origin and evolution of the fauna of free-living ciliated worms (Turbellaria) of Lake Baikal.) Zool. Zhur., 73 (1) : 35–50. (In Russian, with English summary.) 1994b. Freeliving Platyhelminthes - a model group for the evolution of invertebrates in Lake Baikal. Arch. Hydrobiol. Ergeb. Limnol. (Advanc. Limnol.), 44 (K. MARTENS, B. GODDEERIS & G. COULTER, eds., "Speciation in Ancient Lakes") : 183–196. 1996. Comparative analysis of endemic turbellarian faunas of ancient lakes (preliminary rerport). 8th Internat. Symp. Biol. Turbellaria (ISBT), Brisbane, Australia, Program and Abstracts, p. 91 (no. 63).

VARYKHANOVA, K. V., 1989. Zoobentos litorali ozera Khubsugul i ego pritokov. [Littoral zoobenthos of Lake Khubsugul and its tributaries.] Abstract of PhD dissertation, Irkutsk Univ. Press, Irkutsk, pp. 1–24. (In Russan.)

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EXPLANATION OF PLATES I AND II

Plate I

A–C : Photomicrographs of cuticular hooks of *Diplosiphon baikalensis* (RUBTZOV, 1929). A and B, loc. Ayaya Bay (depth, 25 m ; sands with detritus and small rocks) ; July 19, 1982. C, loc. Off Kocherikovskiy Cape (depth, 12–14 m ; rocks with sponges and sands) ; September 17, 1984.

For scale, see Fig. 4.

D–F : Photomicrographs of cuticular hooks of *Diplosiphon mamkaevi mamkaevi* subsp. n. D, loc. Off Krasnyi Yar Cape, Northern Baikal'skoe Village (depth, 38–40 m ; silt with sands and detritus) ; September 12, 1984. E, loc. Off Tyya River mouth (depth, 25–30 m ; sands with silt and detritus) ; September 12, 1984. F, loc. Elgay Bay (depth, 25 m ; sands with silt and detritus) ; September 18, 1984. See Fig. 17 ; Table 1.

For scales, see Figs. 7 and 8.

Plate II

G and H : Photomicrographs of cuticular hooks of a single specimen (1) provisionally included in *Diplosiphon mamkaevi* sp. n. G and H, loc. Off Sagan–Morian Cape (depth, 100 m ; fain-grained sands with silt and detritus) ; September 17, 1984.

For scale, see Fig. 13.

I and J : Photomicrographs of cuticular hooks of *Diplosiphon wadai* sp. n. I and J, loc. The littoral zone of the west coast of Southern Baikal (depth, 10 m) ; September 11, 1986.

For scale, see Fig. 16.

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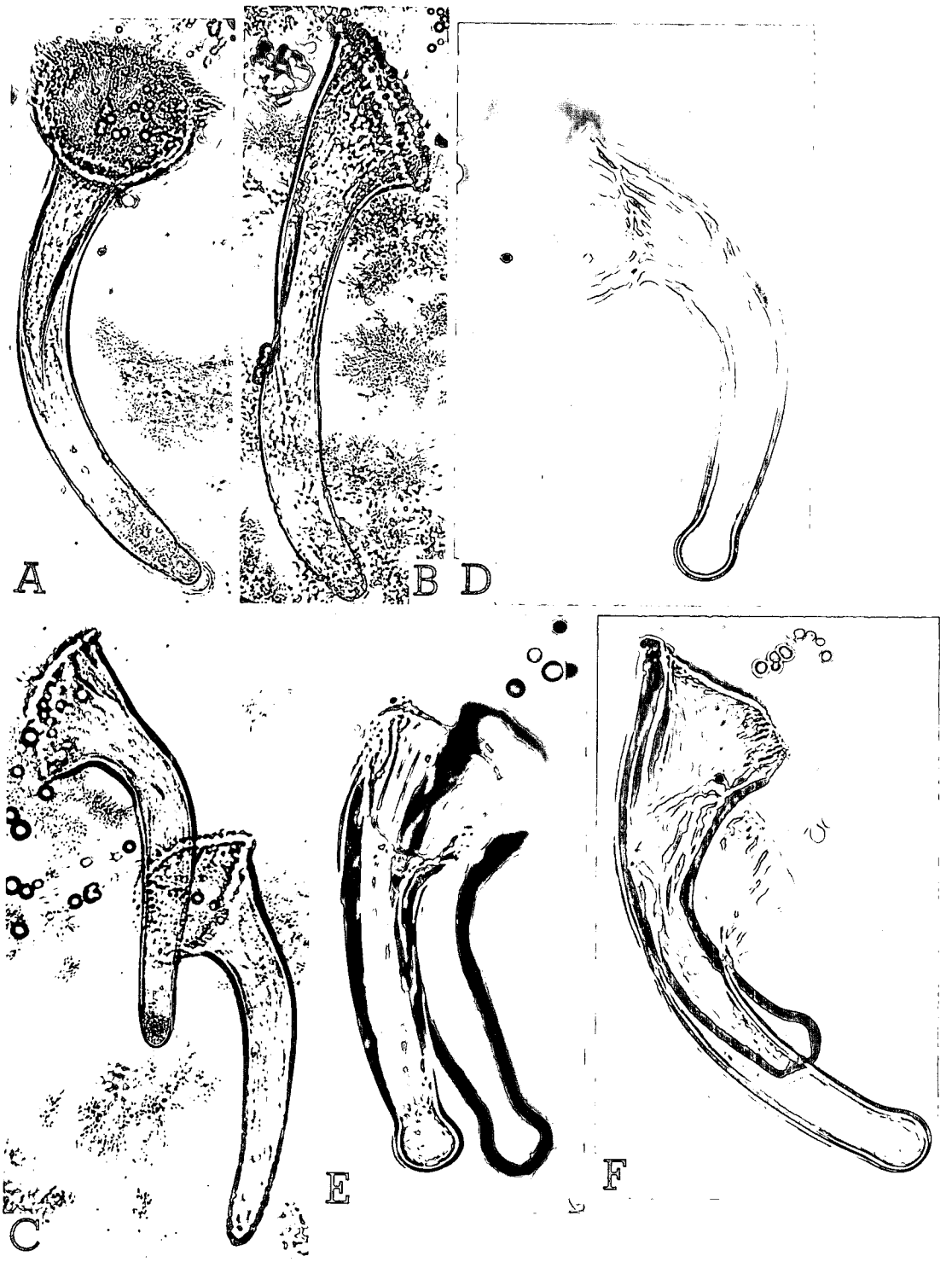
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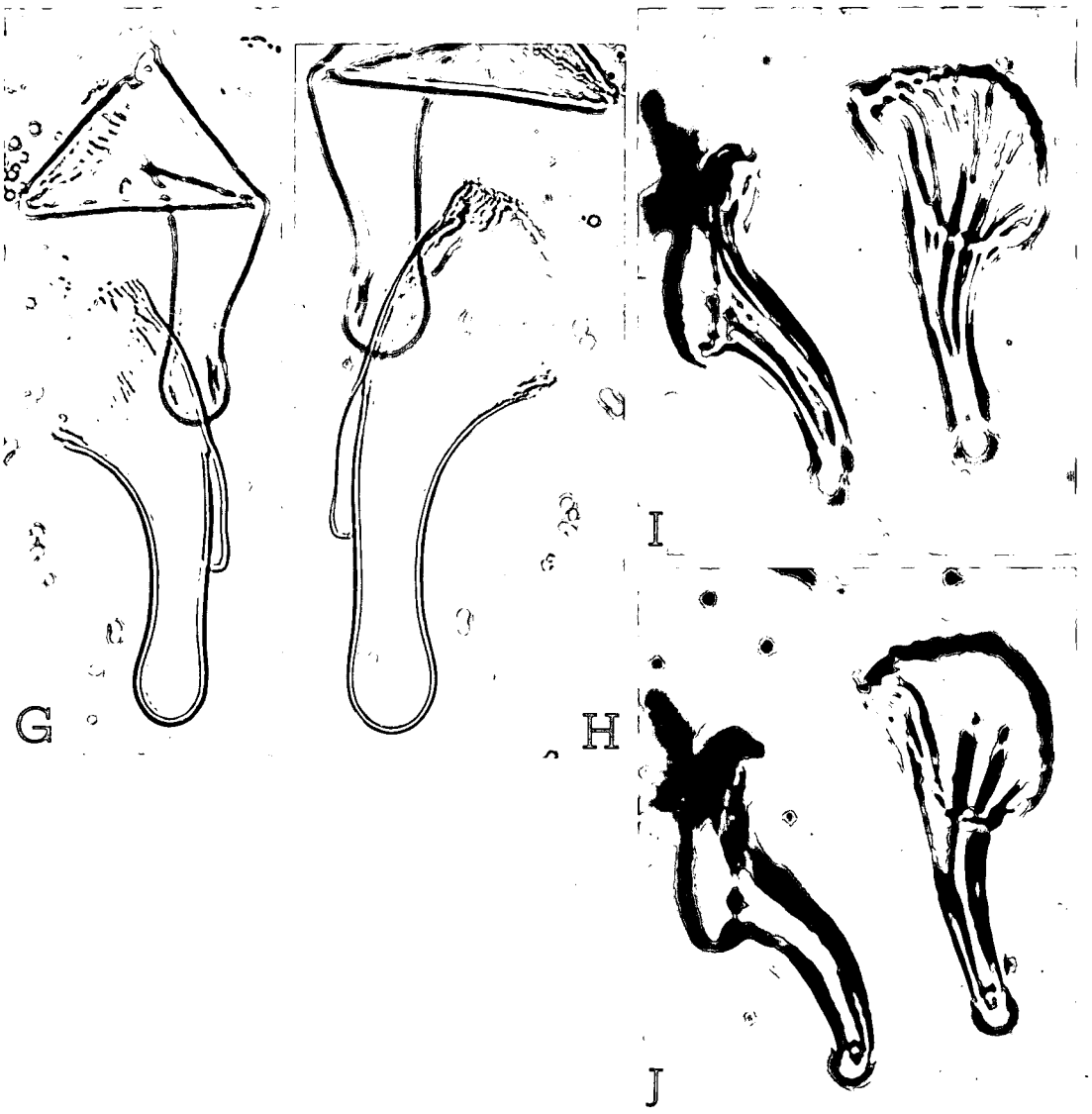
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